Electronic Version
Stylesheet Version v1.1.1

Claims

[c1] A method for determining a frequency profile of a quartz crystal, comprising:
subjecting the quartz crystal to temperature cycles at various temperature rates;
monitoring the crystal frequencies, a crystal temperature parameter, and the temperature rates as the crystal is subjected to the temperature cycles; and
grouping the monitored frequencies correlated with the monitored temperature parameters and temperature rates.

[c2] The method of claim 1, further comprising:
defining a surface in Cartesian three-dimensional space using the grouped frequencies, temperature, and temperature rates.

[c3] The method of claim 2, wherein the grouped frequencies are graphed on the Cartesian z-axis according to $z = f(x, y)$
,
where x is a temperature value and y is a temperature rate.

[c4] 4.The method of claim 3, further comprising performing an interpolation or extrapolation technique to derive missing points on the surface.

[c5] The method of claim 1, further comprising:
d)characterizing the crystal frequency (*f*) as a function of the monitored temperature parameters and temperature rates according to

$$f = f(T, \dot{T})$$

,
where T is a temperature parameter and.

$$\dot{T} = \frac{dT}{dt}$$

[c6] The method of claim 5, further comprising:
graphing the crystal frequency

$$f = f(T, \dot{T})$$

to define a surface in Cartesian three-dimensional space.

[c7] 7.The method of claim 6, further comprising performing

an interpolation or extrapolation technique to derive missing points on the surface.

[c8] 8.The method of claim 1, wherein the crystal temperature parameter is one of a ratio of frequencies representative of temperature or a temperature value.

[c9] 9.The method of claim 1, wherein the crystal temperature parameter is a temperature dependent frequency.

[c10] 10.A method for determining a frequency of a quartz crystal, comprising:
subjecting the quartz crystal to temperature cycles at various temperature rates;
monitoring the crystal frequencies, a crystal temperature parameter, and the temperature rates as the crystal is subjected to the temperature cycles;
grouping the monitored frequencies correlated with the temperature parameters and temperature rates;
d)determining the temperature and a temperature rate of the crystal; and
e)relating the determined crystal temperature and temperature rate to the grouped frequencies to determine the crystal frequency.

[c11] 11.The method of claim 10, wherein step (c) includes defining a surface in Cartesian three-dimensional space

using the grouped frequencies, temperature, and temperature rates.

[c12] 12.The method of claim 11, wherein the crystal frequencies are graphed on the Cartesian z-axis according to

$$\dot{T} = \frac{dT}{dt}$$

,

where x is a temperature parameter and y is a temperature rate in the grouping.

[c13] 13.The method of claim 12, further comprising performing an interpolation or extrapolation technique to derive missing points on the surface.

[c14] 14.The method of claim 10, wherein step (c) includes characterizing the crystal frequency (f) as a function of the monitored temperature parameters and temperature rates according to

$$f = f(T, \dot{T})$$

,

where T is a temperature parameter and.

$$\dot{T} = \frac{dT}{dt}$$

[c15] 15.The method of claim 14, further comprising graphing the crystal frequency

$$f = f(T, \dot{T})$$

to define a surface in Cartesian three-dimensional space.

[c16] 16.The method of claim 15, further comprising performing an interpolation or extrapolation technique to derive missing points on the surface.

[c17] 17.The method of claim 10, wherein step (d) includes determining the crystal temperature when the crystal is located subsurface.

[c18] 18.The method of claim 17, wherein the crystal is disposed in a tool adapted for subsurface disposal.

[c19] 19.The method of claim 10, wherein the crystal temperature parameter is one of a ratio of frequencies representative of temperature or a temperature value.

[c20] 20.The method of claim 10, wherein the crystal temperature parameter is a temperature dependent frequency.

[c21] 21.A method for determining a frequency of a quartz crystal, comprising:
determining a temperature of the quartz crystal;
deriving a temperature rate from the determined crystal temperature; and
relating the crystal temperature and temperature rate to a data set characterizing a correlation between the crystal frequency, temperature, and temperature rates to determine the crystal frequency.

[c22] 22.The method of claim 21, wherein the data set comprises a surface graphed in Cartesian three-dimensional space.

[c23] 23.The method of claim 21, wherein the crystal frequency is determined in real time after determination of the crystal temperature.

[c24] 24.The method of claim 23, wherein the crystal temperature is determined when the crystal is located subsurface.

[c25] 25.The method of claim 24, wherein the crystal is disposed in a tool adapted for subsurface disposal.

[c26] 26.A system for determining the frequency of a quartz crystal, comprising:

a quartz crystal having a frequency output related to a temperature of the crystal; and

a processor adapted to calculate a crystal frequency from a measured temperature parameter of the crystal, a temperature rate of the crystal, and observed frequencies of the crystal correlated with observed temperature parameters and temperature rates of the crystal.

[c27] 27.The system of claim 26, wherein the processor is adapted to characterize a relationship between the crystal frequency (f) and the observed temperature parameters and temperature rates according to

$$f = f(T, \dot{T})$$

,

where T is a temperature parameter and

$$\dot{T} = \frac{dT}{dt}$$

.

[c28] 28.The system of claim 27, wherein the processor is

adapted to perform an interpolation or extrapolation technique to derive the crystal frequency.

[c29] 29.The system of claim 26, wherein the measured crystal temperature parameter is determined for a crystal located subsurface.

[c30] 30.The system of claim 29, wherein the crystal is disposed in a tool adapted for subsurface disposal.

[c31] 31.The system of claim 26, wherein the observed frequencies, temperature parameters, and temperature rates of the crystal form a data set in a storage device operatively coupled to the processor.

[c32] 32.The system of claim 26, wherein the crystal is disposed within a thermally insulated chamber.

[c33] 33.The system of claim 26, wherein the crystal is adapted with a heat conducting material on its surface.

[c34] 34.The system of claim 26, wherein the crystal temperature parameter is one of a ratio of frequencies representative of temperature or a temperature value.

[c35] 35.The system of claim 26, wherein the crystal temperature parameter comprises a number of counts of a temperature dependent frequency mode.